

ASSESSMENT OF WATER QUALITY OF GODAVARI RIVER AT NASHIK, MAHARASHTRA, INDIA

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ABSTRACT

Godavari is the second largest river in India. It originates from Triambakeswar, Nashik, Maharashtra and finally discharges into the Bay of Bengal near Narasapuram in West Godavari district of Andhra Pradesh. The study covers about 24 km of river starting from Gangapur dam to Dasak village. Fifteen locations were selected for collection of water samples from the river and water samples were analysed for water quality parameters. It was observed that untreated or partially treated sewage alongwith industrial wastewater is entering into the river at twelve prominent locations in the study stretch. This data was used to compute the value of National Sanitation Foundation Water Quality Index(NSFWQI), mostly applicable in USA and India. The results of NSFWQI of Godavari river indicates that its water quality as 'Good' (70-90) from Gangapur dam to Someshwar, 'Bad' (25-50) from Aanadwalli bridge to Samtanagar and 'Very bad' (0-25) at Agartakli STP downstream. Based upon the results, the existing conservation measures have been reviewed and additional measures are suggested. The study concludes that infiltration of sewage is the main precursor of Godavari river pollution and available sewage treatment facilities in the region are inadequate.

Key words: Water quality index, Sewage treatment plant and BOD

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1. INTRODUCTION

Unregulated growth of urban areas, particularly over the last two decades, without providing infrastructure services for proper collection, transportation, treatment and disposal of domestic waste led to increased pollution and health hazards. The municipalities and such civic authorities have not been able to cope up with this massive task which could be attributed to various reasons including erosion of authority, inability to raise revenues and inadequate managerial capabilities. In India all 15 major rivers have become polluted. Ganga, Godavari, Gomti, Cavery, Narmada and Mahi all are facing pollution problems. The Ganga from Haridwar to Calcutta is infected by an unending sewer fit only to carry urban liquid waste^[4], half burnt dead bodies, pesticides and other wastes. The chief sources of water pollution are (i) sewage and other waste (ii) industrial effluents (iii) agricultural discharges and industrial wastes from chemical industries, fossil fuel plants.

The objectives of the present study are

1. To investigate water quality of River Godavari at Nashik station, Maharashtra state, India
2. To identify the point sources of pollution like industries, those are discharging their untreated or partially treated wastewater /solid waste in the Godavari River in the selected reach/portion of the river.
3. Identification of the selected river reaches as per Classification of inland surface waters (CPCB standards)

2. STUDY AREA

The Godavari River runs from western to southern India and is considered to be one of the big river basins in India. With a length of 1465 km, it is the second largest river in India (only after the Ganges), that runs within the country. Godavari river originates from Brahmagiri Mountain (at 19.5600°N, 73.2000°E) having 920 m elevation located at Triambakeswar in the Nashik District of Maharashtra. It discharges into the Bay of Bengal near Narasapuram in West Godavari district of Andhra Pradesh. The major towns located along the river in Maharashtra are Triambakeswar, Nashik, Kopergaon, Paithan, Gangakhed, Nanded, Sironcha, Gevrai (Beed) while in Telangana & Andhra Pradesh are Adilabad, Nizamabad, Dharmapuri, Warangal, Bhadrachalam, Rajamundry, Yanam, Kovvur, Tallapudi, Narasapur, Antarvedi, Tadipudi etc.

Nashik city gets around 390 million litres per day (MLD) drinking water, out of which sewage of around 310 MLD is generated. The Nashik Municipal Corporation (NMC) is treating 200.5 MLD sewage (as given in Table 7) in the installed Sewage treatment plants; while the remaining 110 MLD untreated sewage is directly released in Godavari river (as per status in March 2014).



Figure 1 Location Map of Study Area



Figure 2 Location Map of Water Quality Monitoring Stations and Waste Water Addition Points in Nashik

3. MATERIALS & METHODS

The study has covered about 24 km length of the river starting from Gangapur Dam to Dasak Village. Fifteen important river water sampling stations selected in the Study length were from Gangapur Dam to Dasak Village namely Someshwar, Anandwalli, Victoria Bridge, Ramkund, Tapowan, Dasak Village etc. River water sampling locations are given in the Figure 2 & Table 1.

Water samples were collected as per standard methods of Sampling techniques as described in APHA(2012)^[11]. Analysis of the water samples were done as per standard methods of water & waste water examination, APHA (2012). Various physico-chemical parameters such as temperature, pH, Electrical conductivity(EC), Alkalinity, Total Hardness (TH), Total Dissolved solids (TDS), Total Suspended Solids (TSS), Total Solids (TS), Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Phosphate (PO_4^{3-}), Turbidity were determined at all the sampling stations. pH was determined on the spot using pH Pen and DO of the

samples was fixed on site using manganous sulphate & alkali azide solutions. DO was then determined using Winkler's method^[7]. hardness was estimated using EDTA titrimetry, phosphates by molybdenum blue complex formation using a spectrophotometer. Turbidity was determined using nephelometer.

Table 1 River Water Sampling Stations along the Stretch of Godavari River (refer Fig. 2)

Sampling station	Location	Distance from the 1 st Sampling station	Remarks
S1	Gangapur Dam	0.0 km	Dam is source of drinking water
S2	Balaji Temple	4.0 km	Bathing, washing activities
S3	Someshwar	6.0 km	Bathing activity and Puja material thrown
S4	Anandwalli Bridge	10.2km	Sewage from MIDC area, hotels, anandwalli slum area meets to river
S5	Bapu Bridge	10.7 km	Sewage of Anandwalli slum area discharged to river
S6	Suyojit Bridge	11.5 km	Part of untreated sewage of gangapur area meets to river
S7	Chopda Lawns	12.5 km	Sewage entering through 3 no. visible sewers
S8	Victoria Bridge	14.7 km	Wastewater stream entering to the river
S9	Ramkund	15.5 km	Mass bathing activities, Dashkriyavidhi material thrown
S10	Ghadge Baba Bridge	16.0 km	No Point source contributing wastewater could be identified
S11	Vijaynagar Bridge	17.0 km	Waghadi river meets in rainy season
S12	50m after Tapovan STP	18.5 km	Treated sewage from 78 and 52 MLD STP meets the river
S13	Samtanagar Bridge	20.0 km	Nasardi nala(river) joins the river, before this point
S14	50m after Agartakli STP	21.0 km	Untreated sewage from 70 MLD STP entering the river
S15	Dasak Bridge	24.0 km	Remains/ashes of human dead bodies, wastewater from settlements, vehicle washings are added

Table 2 Sewage/Wastewater addition points along the Stretch of Godavari River (refer Fig. 2)

Station no.	Name of Point Source of Pollution	Station no.	Name of Point Source of Pollution
P1	Gangapur Nala	P7	Sewer near Chopada Lawns
P2	Chikhli Nala	P8	Lendi Nala near Ramwadi
P3	Anandwalli Nala	P9	Flowing sewage at Ramghat
P4	700m from Anandwalli Bridge	P10	Sewage from Tapovan STP **
P5	Asarambapu Nala	P11	Nasardi Nala near Samtanagar
P6	Nala near Suyojit Housing Society	P12	Sewage from Tapovan STP **

** Treated sewage not meeting to Effluent standards

4. RESULTS & DISCUSSION

River water quality was observed at the 15 no. sampling stations as per table no.1 and the analysis results have been shown for January & March 2014 month as per table 2 &3. Water quality at selected stations was determined using National Sanitation Foundation Water Quality Index (NSFWQI), which is the most widely used water quality index throughout the world. To calculate NSFWQI value nine parameters namely Dissolved Oxygen, Faecal Coliform, pH, Biochemical Oxygen Demand, Temperature change, Total Phosphate, Nitrate, Turbidity & Total Solids are used^[13]. These parameters have been given weightages as mentioned in table 4. Dissolved Oxygen(D.O.) and Faecal Coliform were considered more important so relatively more weightages were given to them as compared to the remaining parameters.

For each of these nine parameters, standard Charts are available. From these Charts (refer figure 3) , Q Value of each parameter is determined. The Q Value and the weightage of each of these nine parameters is used to determine the NSFWQI value at the selected station. Water quality at the station is classified as Excellent, Good or Bad with reference to the calculated value of NSFWQI as per table 6.

Table 3 Data of Godavari river water quality (January 2014)

Station No.	Parameters/ Sampling Station	DO (mg/L)	Faecal Coliform (MPN Index/100ml) (X10 ⁴)	pH	BOD ₅ (mg/L)	Phosphate (mg/L)	Turbidity (NTU)	Total Solids (mg/L)	TDS (mg/L)	Total Coliform (MPN Index/100ml) (X10 ⁴)	NSFWQI
S1	Gangapur	7.5	N.M.*	8.6	2	0.1	4.56	90	69	N.M.*	81
S2	Balaji	7.4	N.M.*	8.5	4	0.16	5.2	94	72	N.M.*	78
S3	Someshwar	7.3	N.M.*	8.3	4	0.18	5.5	116	89	N.M.*	78
S4	Anandwalli	3.4	5.4	8.4	26	0.2	4.61	202	155	8.4	43
S5	Bapu Bridge	3.2	16	7.9	29	0.21	9.98	241	185	26	42
S6	Suyojit	3.3	10	8.1	26	0.24	15.57	367	282	14	39
S7	Chopra	2	18	8.4	37	0.16	15.54	411	316	28	36
S8	Victoria	4.4	15	8.6	24	1.22	15.49	361	278	23	33
S9	Ramkund	2.1	24	8.9	34	1.62	14.63	367	282	44	26
S10	Ghadge Baba Bridge	1.6	14	7.8	40	1.46	12.11	497	382	22	30
S11	Vijay Nagar	2	10	7.7	36	1.54	13.58	315	242	21	32
S12	Tapovan	3.4	22	7.5	28	1.92	11.14	560	431	35	31
S13	Samta	1.2	24	7.3	46	2.12	33.75	673	518	44	26
S14	Agartakli	0.2	38	7.8	60	2.24	29.36	589	453	54	25
S15	Dasak	3.2	48	7.8	26	2.12	23.44	628	483	78	29

Table 4 Data of Godavari river water quality (March 2014)

Station no	Parameters/ Sampling Station	DO (mg/L)	Faecal Coliform (MPN Index/100ml) (X10 ⁴)	pH	BOD ₅ (mg/L)	Phosphate (mg/L)	Turbidity (NTU)	Total Solids (mg/L)	TDS (mg/L)	Total Coliform (MPN Index/100ml) (X10 ⁴)	NSFWQI
S1	Gangapur	7.3	N.M.*	8.4	2	0.1	5.2	67.6	52	N.M.*	82
S2	Balaji	7.1	N.M.*	8.3	3	0.14	6.1	88.4	68	N.M.*	79
S3	Someshwar	7.2	N.M.*	8.2	4	0.16	6.2	106.6	82	N.M.*	79
S4	Anandwalli	4.2	2.7	8.1	24	0.2	7.59	170.3	131	4.7	46
S5	Bapu Bridge	3.2	54	7.8	26	0.22	8.98	237.9	183	92	44
S6	Suyojit	3	1.3	8.4	28	0.24	14.7	429	330	2.3	38
S7	Chopra	1.3	1	8.4	41	0.18	23.68	267.8	206	1.2	37
S8	Victoria	3.1	1.3	8.9	27	1.08	11.07	289.9	223	2.3	34
S9	Ramkund	3	24	8.3	32	1.44	15.43	274.3	211	54	31
S10	Ghadge Baba Bridge	1.9	14	8.5	36	1.32	20.56	413.4	318	24	27
S11	Vijay Nagar	3.1	10	8.2	28	1.46	19.68	348.4	268	21	31
S12	Tapovan	2.9	22	7.7	30	1.88	18.06	443.3	341	35	31
S13	Samta Nagar	1.4	24	7.5	40	2.02	34.8	439.4	338	54	26
S14	Agartakli	0.2	28	7.6	52	2.32	36.84	445.9	343	35	24
S15	Dasak	2.6	54	7.4	27	2.16	25.59	438.1	337	92	29

*Not Measured

Table 5 NSFWQI Water Quality Factors and Weights ^[14]

Sr. No.	Parameter	Weight
1	Dissolved Oxygen	0.17
2	Faecal Coliform	0.16
3	pH	0.11
4	Biochemical Oxygen demand	0.11
5	Temperature change	0.10
6	Total Phosphates	0.10
7	Nitrates	0.10
8	Turbidity	0.08
9	Total Solids	0.07

The concentration of DO is one of the most important indices of purity of river water. The concentration of DO in water represents the nature of organic matter present. The DO of river water is less than 5 mg/l, from Anandwalli Bridge to Dasak Bridge, so the river water is unsuitable for survival of aquatic life, in this stretch. River water falls in 'E' class, considering the DO parameter alone.

BOD₅ values shows sudden rise from Someshwar to Anandwalli Bridge & even more than 25 mg/L at all the stations from Anandwalli area onwards in the selected

stretch. This is due to the sewage entering to Godavari between Someshwar & Anandwalli from Gangapur nala (P1) & Anandwalli nala (P3), while Chikhli nala (P2) discharges MIDC industrial wastewater to Godavari before Anandwalli area,

Table 6 NSF Water Quality Index Table^[14]

Sr. No.	NSFWQI Range	Water Quality
1	90-100	Excellent
2	70-90	Good
3	50-70	Medium
4	25-50	Bad
5	0-25	Very Bad

In the month of January & March 2014, it was observed that BOD₅ at Chopada lawns (station 8) became 37 & 41 mg/L, due to discharge of sewage from nala (P6) near Suyojit Housing Society & clearly visible sewers (P7) near Chopada Lawns.

The river does not get chance of cleansing via self purification process, since Lendi Nala (P8) and entering sewage (P9) in ramkund area increases the BOD₅ further to 40 mg/L in January month at Ghadge Baba Bridge.

Nasardi nala brings the sewage of Pimpalgaon slum area & industrial wastewater of MIDC AMBAD and finally downpours it before Samtanagar, aggravating the BOD₅ value to 46 mg/L in January month. At Agartakli new 70 MLD STP have been constructed, but its commissioning was not done, so around 70 MLD untreated sewage is just passing through the STP & entering to Godavari near Agartakli. This has increased the BOD₅ value of Godavari to 60 mg/L at a distance of 50 m from Agartakli STP (station 14).

From Agartakli to Dasak area, no predominant nalas are entering to Godavari, so river shows little improvement in its BOD₅ value, due to self purification process. Turbidity and Total solids are also increasing proportionately at all the selected stations of study stretch due to addition of sewage & industrial wastewater by one or the other nala.

Eutrophication phenomenon takes place in the water body, if the water body is rich in Nitrate and Phosphate content. Nitrate and Phosphate content of water body usually increases, if the agricultural runoff or sewage is entering to the water body. In this case agricultural runoff was found to be meeting to Nasardi nala near Pimpalgaon area after Papaya Nursery and sewage was entering to the river via number of nalas as discussed.^[16] This is leading to the formation of green coloured substance as Water Hyacinth and Algal bloom at the water body at most of the stations like Bapu Bridge, Ghadge Baba bridge & Agartakli STP area. So, most of the stretch of Godavari has been found to be unsuitable for navigational and recreational purpose.

Fecal Coliform presence shows the indication of contamination of water due to human or animal feces. Fecal Coliform from Anandwalli to Dasak Bridge is considerably high and in the range of 5.4×10^4 to 48×10^4 indicating the heavy contamination of the river stretch. The value of fecal coliform increases at station no. 12 i.e. 50m after Tapovan STP due to discharge of sewage containing fecal coliform in the range of 10^5 to 10^6 and BOD₅ in the range of 40 to 50 mg/L. This clearly indicates

the poorly operated Tapovan STP having inefficient chlorination of the finally treated sewage coming out of the STP. The value of fecal coliform reaches to alarming stage at Agartakli and Dasak Bridge.

National sanitation foundation water quality index (NSFWQI) was calculated to identify the water quality at the selected stations. It is evident from the referred literature that this water quality index does not show appreciable change in the value, if 2-3 parameters are not considered.^[17] In the present study seven number of parameters namely DO, fecal coliform, pH, BOD₅, Phosphate, Turbidity & Total Solids were considered out of nine parameters.

The value of NSFWQI from Gangapur dam to Someshwar is in the range of 87 to 84 in March and 81 to 78 in January 2014, on referring the table 5, it is adjudged that water quality is good in this stretch up to Someshwar. Water quality deteriorates comparatively at Anandwalli, since NSFWQI value is 38 and 43 in March and January respectively. So, water quality is reported as 'Bad' at Anandwalli. This is due to discharge of sewage by Gangapurnala, Chikhlinala and Anandwallinala between Someshwar and Anandwalli river stretch.

The water quality does not get the chance to recuperate after Anandwalli, since Suyojit nala & public sewers at Chopada lawns further discharge the sewage in the Godavari before Chopada lawns, bringing down the WQI value to 36 at this station in January month. Water quality deteriorates further at Ramkund having WQI as 26, due to mass bathing and deliberate addition of Puja and last ritual materials at this religious place; These activities goes unchecked at Ramkund, since people of entire Maharashtra wish to perform the last rituals of their kiths & kins here according to hindu mythology.

Nasardinala brings the sewage of Pimpalgaon & Ambad slum area and discharges it in Godavari near Samtanagar, reducing the WQI value to 26 in January and March months. Further it is observed that 70 MLD STP at Agartakli is almost ready except sludge digester, but commissioning of STP has not been done, therefore sewage is just passing through the Agartakli STP and effluent coming out from STP shows no appreciable change in the quality that it has undergone treatment. Further there is little change in the calculated value of WQI after Agartakli STP (station S14), this is due to the fact that present NSFWQI does not take into consideration the effect of BOD₅, if the value of BOD is above 30 mg/l. This is the fact, due to which the WQI value at Samtanagar (station 13) and After Agartakli (station 14) is almost same though the BOD₅ value are 46 mg/l and 60 mg/l respectively. In Indian rivers like Ganga, Yamuna and Godavari BOD₅ value above 30 mg/l have been observed earlier^[6], so there is a gap in research area that BOD₅ rating curve should also take into consideration BOD₅ value upto 80 mg/l. Hence there is a need of refinement of BOD₅ rating curve or new water quality index should be developed, which will predominantly represent/consider the actual water quality status of Indian rivers.

5. CONCLUSIONS

The assessment of water quality of 24 km stretch of Godavari river from Gangapur dam to Dasak village in Nashik indicates that the river is heavily polluted due to entry of untreated or partially treated sewage in the river from different point sources of pollution. There is appreciable change in water quality from good to bad, from Someshwar to Anandwalli area, as evident from the value of NSFWAI at these stations. This is due to discharge of sewage and industrial wastewater via Someshwarnala, ChikhliNala and Anandwallinala in this stretch. Further, effluent

from poorly operated Tapovan STP adds to the woes of Godavari and its quality goes on deteriorating in the downstream portion.

In the entire river stretch deoxygenation process predominates over reoxygenation process, so river does not get the chance to recuperate via self purification process. Therefore zones of recovery were not observed. Nasardinala brings the untreated sewage of Pimpalgaon region and Ambad MIDC area and discharges near Samtanagar. Similarly 70 MLD STP at Agartakli has not been commissioned, so 70 MLD untreated sewage is directly discharged to Godavari after Agartakli STP. Therefore the water quality changes from bad to very bad, from Samtanagar to Agartakli STP downstream region.

Existing NSFQI does not take into consideration the effect of BOD₅ value of river from 30 mg/l to 60 mg/l, therefore the value of NSFQI at Samtanagar and Agartakli STP downstream does not show much difference, though the BOD₅ values at these stations are considerably different and are 46 and 60 mg/l in January month. So, there is a need of refinement of existing BOD₅ rating curve of NSFQI. If such refinement is done, then one more water quality as 'Worst' may be added after 'Very bad' water quality in NSFQI. It is anticipated that water quality at Agartakli STP downstream may be 'Worst' rather than 'Very bad'. At present Anandwalli to Dasak bridge stretch of Godavari comes under Class 'E' river as per CPCB guidelines of classification of inland surface waters.

It is suggested that Nasardi nala discharge should be diverted to Agartakli sewage pumping station and commissioning of 70 MLD STP along with construction of 40 MLD STP at Agartakli should be completed soon. In addition to this, one New 40 MLD STP near Gangapur area should be constructed and 3 no. nalas of Someshwar to Anandwalli stretch should be diverted to this New STP at Gangapur area. Municipal Corporation should take efforts to divert the remaining downpouring nalas of Godavari, so that old pure and sacred status of Godavari can be restored.

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